Evolution and Biodiversity in the Antarctic (EBA)
Report 2005

Introduction

Evolution and Biodiversity in the Antarctic (EBA) is a new and ambitious programme of research under the SCAR umbrella that sets out to:

- Understand the evolution and diversity of life in the Antarctic.
- Determine how these have influenced the properties and dynamics of present Antarctic ecosystems and the Southern Ocean system.
- Make predictions on how organisms and communities are responding and will respond to current and future environmental change.
- Identify EBA science outcomes that are relevant to conservation policy and to communicate this science to the SCAR Antarctic Treat System and other stakeholders by appropriate routes.

The structure of the programme is based around five major unifying key questions, drawn together as workpackages, that are addressed across the realms of terrestrial, limnetic and marine environments. In order to encourage integration of studies and findings across these realms and across the geographic spread of the Antarctic activities of contributing nations, the overall programme and workpackages have been intentionally structured so as to be jointly led by representatives widely recognized within the Antarctic marine, terrestrial and limnetic biological research communities. In doing so, the programme brings together a wide range of disciplines to tackle a series of well-focused questions. These disciplines include plate tectonics, climatology, glaciology, geophysics, oceanography, paleontology, molecular biology, taxonomy, biogeography, autecology, cellular and organism-level ecophysiology, and community ecology.

Agreed Work Packages

1. Evolutionary history of Antarctic organisms

Key scientific areas to be investigated will include:

1. Vicariance and Radiations: When did the key radiations of Antarctic taxa take place? (key groups will be focused upon)
2. Impact of glaciation: on land (habitat modification/loss and timing and extent of isolation); at sea (evolutionary links between continental shelf and slope or deep-sea species).
3. Phylogeography: geographical structure and relationships in the Antarctic biome.
4. Evolutionary history of Antarctic micro-organisms (both prokaryotic and eukaryotic).

2. Evolutionary adaptation to the Antarctic environment

Key scientific areas to be investigated will include:

1. Adaptations and their integration into life history pattern in Antarctic organisms

The life history pattern of an organism integrates the proximate adaptations (genomic, biochemical, cellular, physiological, structural and behavioural) in response to the

biophysical environments. As such, life history patterns enable successful reproduction and survival in response to the variability or stability of both the biological (eg competition, predation) and physical (eg temperature, water availability, pressure, etc) environments.

3. Patterns of gene flow within, into and out of the Antarctic, and consequences for population dynamics: isolation as a driving force

Key scientific areas to be investigated will include:

1. Population structure and dynamics in the context of evolutionary biology.
2. Natural and anthropogenic dispersal processes: immigration and emigration of organisms; intra-Antarctic dispersal; the role of advective/transport processes in gene flow and population structure.
3. Genetic structure of populations: differences among and between Antarctic and non-Antarctic populations
4. The extent to which populations of Antarctic organisms exist as metapopulations.

4. Patterns and diversity of organisms, ecosystems and habitats in the Antarctic, and controlling processes.

Key scientific areas to be investigated will include:

1. Biodiversity: to what extent is the diversity of the Antarctic biota underestimated (both standard & cryptic species)?
2. Spatial and temporal variations in diversity: variation of diversity at different spatial scales within the Antarctic and within defined time frames.
3. Response to latitudinal and environmental gradients: local, regional and global.
4. Unknown areas: patterns of diversity and biotic composition of unexplored but important areas (e.g. deep sea, inland nunataks, isolated islands, subglacial lakes).

5. Impact of past, current and predicted future environmental change on biodiversity, and the consequences for Antarctic marine, terrestrial and limnetic ecosystem function

Key scientific areas to be investigated will include:

1. Interactions between introduced and indigenous species in selected environments under climate change.
2. Effect of abiotic change on biota
3. Modelling interactions between environmental change and organism responses in order to predict biotic change.
4. Impact of biological feedback on climate

Steering Committee

Co-chair: Guido di Prisco (Italy, marine, also representing ICEFISH)

Co-chair: Pete Convey (UK, terrestrial)

Secretary: Dana Bergstrom (AUS, terrestrial)

Member: Angelika Brandt (D, marine)

Member: Marc Lebouvier (F, conservation matters)

Ex officio: Ad Huiskes (NL, terrestrial, Chief Officer Life Sciences Standing Scientific Group of SCAR)

Census of Antarctic Marine Life (CAML): Michael Stoddart (AUS, marine)

Workpackage Leaders

WP1: Brigitte Hilbig (D, marine, also representing ANDEEP-SYSTCO), Dominic Hodgson (UK, terrestrial)

WP2: Dan Costa (US, marine), Takeshi Naganuma (Jap, terrestrial, also representing MERGE)

WP3: Antonio Mateo Sole-Cava (Brazil, marine), Ian Hogg (NZ, terrestrial)

WP4: Julian Gutt (D, marine), Satoshi Imura (Jap, freshwater)

WP5: Edith Fanta (Brazil, marine), Tad Day (US, terrestrial)

Milestones

EBA came into existence when its science implementation plan and proposed Steering Committee were formally approved by the SCAR Executive in November 2005. The finalisation and agreement by participating scientists of these two items, for submission to the SCAR Executive, was therefore a main focus of the 2005 SCAR Biology Meeting (Curitiba, Brazil). The nominated workpackage leaders for each package (two for each, drawn from the international marine and terrestrial biology communities within SCAR) were then circulated widely amongst the EBA community after the meeting, before being formally approached.

While not formally part of EBA itself, it is important to highlight the role played by the predecessor SCAR programmes Evolanta and RiSCC (which were formally wound up at SCAR Curitiba) and EASIZ, formally completed in 2004, in the development of the EBA science programme, and in contributing to its member scientific community.

The SCAR Hobart Open Science Conference therefore provides the first opportunity since the programme's formal adoption for its members to meet. EBA scientists will use this opportunity to give high profile keynote presentations on EBA itself (Fanta, Brazil) and its predecessor biological programmes (Bergstrom, AUS; Rodhouse, UK), as well as keynotes at the pre-meeting International Forum on the Sub-Antarctic (Bergstrom, AUS; Convey, UK). Many Open Science Meeting presentations will be given by EBA members, who will also contribute further to specific workshops arranged throughout the conference, in particular those of CAML and LGP, and the Inter-Programme Workshop.

Outputs

At this early stage of the programme's life, outputs take the form of:

- EBA personnel have taken over and continued the production of the major RiSCC product, the volume " *Trends in Antarctic Terrestrial and Limnetic Ecosystems*, eds. Bergstrom, D.M**,** Convey, P. & Huiskes, A.H.L. Springer, Dordrecht"; the volume is due for publication in late summer 2006, and includes 16 chapters prepared by 39 authors.
- EBA personnel are now responsible for the main products of EVOLANTA, i.e. research on evolutionary biology of Antarctic organisms
- EBA personnel are now responsible for completing the coordination of the output of the EASIZ programme closing meeting (special issue of *Deep Sea Research*)
- An EBA special journal issue (*Antarctic Science*, eds. Fanta, Arntz, Detrich, Kawal, and Walton) arising from Curitiba
- EBA starting to appear in the acknowledgements to new scientific papers of involved scientists, bringing it and SCAR to the notice of the wider scientific community (examples listed in Appendix)
- Formalised EBA contribution to IPY, in the form of the endorsed programmes EBA, Tarantella, MERGE, Aliens in Antarctica, CAML, ICEFISH, CCAMLR, ANDEEP-SYSTCO, SCAR-MarBIN, CLICOPEN, HABIPOL, HERMES, IAI, SVALBASE, TUNU, ARCTOS, Pole-to-Pole
- Formalised EBA contribution to CAML
- Participation in ICEFISH Symposium (organized by HW Detrich at the Darling Marine Center, Univ of Maine; August 21st-25th, 2005), illustrating links between the IPY-endorsed EBA and ICEFISH
- Participation in SCAR inter-programme workshop (Amsterdam, Nov 2005), when links were established with the other SCAR programmes SALE, ACE, AGCS; this to be developed further at the Inter-Programme workshop in Hobart.
- Contribution (Frenot, FRA; Convey, UK) to the "Non-Native species in the Antarctic" workshop (Christchurch, April 2006; organised by Gateway Antarctica and Antarctica New Zealand), and subsequent development of proposals to CEP meeting, Edinburgh, June 2005.

Finances

2005 expenditure:

a) Terrestrial database $3000
b) MarbIN Workshop $3000.01
c) EBA SSC Workshop Cambridge $6099.59
d) Carried forward $8900.40

2006 expenditure:

a) publication costs of *Antarctic Science* EBA Symposium Special Issue, $10,000
b) future workshop schedule and costs to be defined at Hobart Open Science Meeting.

Appendix – example publications citing EBA support

Brinkmann, M., Pearce, D.A., Convey, P. & Ott, S. The cyanobacterial community of polygon soils at an Antarctic terrestrial inland site – Coal Nunatak, Alexander Island. *Polar Biology* (in press).

Chown, S.L. & Convey, P. Spatial and temporal variability across life's hierarchies in the terrestrial Antarctic. *Phil Trans Roy Soc Lond B* (in press).

Convey, P. Antarctic terrestrial biodiversity – patterns and problems. *Proceedings of Malaysian International Antarctic Science Congress* (in review).

Convey, P. Antarctic Ecosystems. *Encyclopedia of Biodiversity*, 2nd Edition, ed. S.A. Levin. Elsevier, San Diego (in review).

Convey, P., Barnes, D.K.A., Clark, M.S. Dominic A. Hodgson, D.A. & Peck, L.S. An holistic approach to understanding the biological impacts of climate change: Antarctica as a planetary warning system. *Inside Agriculture* (in review).

Convey, P. & Smith, R.I.L. Thermal relationships of bryophytes from geothermal habitats in the South Sandwich Islands, maritime Antarctic. *Journal of Vegetation Science* (in press).

Giordano D, Grassi L, Parisi E, Bargelloni L, di Prisco G, Verde C (2006) Embryonic b-globin in the non-Antarctic notothenioid fish *Cottoperca gobio* (Bovichtidae). *Polar Biology* (in press).

Maslen, N.R. & Convey, P. Nematode diversity and distribution in the southern maritime Antarctic – clues to history? *Soil Biology and Biochemistry* (in press).

Mazzarella L, Bonomi G, Lubrano MC, Merlino A, Riccio A, Vergara A, Vitagliano L, Verde C, di Prisco G (2006) Minimal structural requirements for Root effect: crystal structure of the cathodic hemoglobin isolated from the antarctic fish *Trematomus newnesi*. *Proteins* **62**: 316-321

Peat, H.J., Clarke, A. & Convey, P. Diversity and biogeography of the Antarctic flora. *Journal of Biogeography* (in press).

Verde C, De Rosa MC, Giordano D, Mosca D, de Pascale D, Raiola L, Cocca E, Carratore V, Giardina B, di Prisco G (2005) Structure, function and molecular adaptations of haemoglobins of the polar cartilaginous fish *Bathyraja eatonii* and *Raja hyperborea*. *Biochem J* **389**: 297-306

Verde C, di Prisco G (2006) The adaptive evolution of polar fishes: structure, function and molecular phylogeny of hemoglobin. *Memoirs of National Institute of Polar Research, Special Issue* No. **59** (in press)

Verde C, Parisi E, di Prisco G (2006) Non-Antarctic primitive and modern notothenioid fish species: tracking the adaptive evolution in the structure, function and molecular phylogeny of hemoglobin. *Deep Sea Research* (in press)

Verde C, Parisi E, di Prisco G (2006) The evolution of thermal adaptation in polar fish. *Gene* (in press)

Verde C, Balestrieri M, de Pascale D, Pagnozzi D, Lecointre G, di Prisco G (2006) The oxygen-transport system in three species of the boreal fish family Gadidae. Molecular phylogeny of hemoglobin *J Biol Chem* (in press).

Waller C.L., Worland M.R., Convey P. & Barnes D.K.A. Ecophysiological strategies of Antarctic intertidal invertebrates faced with freezing stress. *Polar Biology* (in press).

Waller, C., Barnes, D.K.A. & Convey, P. Ecological contrasts across an Antarctic land-sea interface. *Austral Ecology* (in press).